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RESOLUTION AND MICROPHOTOMETRIC GRANULARITY OF INFRARED FILMS

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RESOLUTION AND MICROPHOTOMETRIC GRANULARITY OF INFRARED FILMS[1]

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Results of an experimental investigation of the resolving power of several photographic IR films. Measurement with a resolvometer revealed that the resolution is strongly dependent on the frequency of the incident light, being about twice as high for violet as for red light. A check of these results using the contact method confirmed the original findings. Possible mechanisms for this effect are discussed.

The I-810, I-920, I-1030 and I-1070 infrared films developed by the Kazan Branch of the Scientific Research Institute of Motion Picture Photography (NIKFI) (ref. 1) have been thoroughly studied at the Main Astronomical Observatory of the USSR Academy of Sciences (ref. 2). During work on the films it was noted that their resolution is strongly dependent on the spectral composition of the light to which they are exposed. /59*

The resolution was determined by exposure in the resolvometer of the All-Union Scientific Research Institute of Metrology (VNIIM) (ref. 3) with an OS-16 apochromat objective lens. The light source was an incandescent lamp with a KS-14 red light filter, a violet light filter (maximum transmission at about 450 mμ) or with no light filter (conventional white light). It is clearly evident from the curve of spectral sensitivity for the infrared films (ref. 2) that the image in the first case is basically composed of infrared rays. The results are given in table 1.

As may be seen from the table, the resolution of films in violet rays is more than twice that in infrared rays. When the images on the test slide are examined under the microscope in these rays it is hard to believe that they are taken on the same film.

It is extremely improbable that this phenomenon is due to large aberrations of the objective lens in the infrared region of the spectrum. Nevertheless, special experiments were set up to entirely rule out the effect of the objective lens.

In order to do this, the resolution of the infrared films was determined by the secondary contact method (ref. 4), i.e., by contact-printing a small test negative on the film. In these experiments, the violet light filter was replaced by a blue filter with a wider transmission band (which resulted in somewhat lower values of R). The results are given in table 2.

As may be seen from the table, even in this case the R for infrared rays is little more than half that for blue rays.

*Numbers given in margin indicate pagination in original foreign text.
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TABLE 1. RESOLVING POWER R (mm^{-1}) MEASURED IN THE RESOLVOMETER OF THE ALL-UNION SCIENTIFIC RESEARCH INSTITUTE OF METROLOGY.

Film	Light filters		Without filter
	Red	Violet	
I-810	52	115	60
I-920	50	125	74
I-1030	52	115	85
I-1070	52	125	88

TABLE 2. RESOLVING POWER R (mm^{-1}) MEASURED BY THE CONTACT METHOD.

Film	Light filters		Without filter
	Red	Blue	
I-810	62	100	67
I-920	56	90	70
I-1030	50	100	95
I-1070	50	90	90

The reason for this phenomenon is quite obvious. As has been previously shown (ref. 5), the nature of the relationship between the resolution of photographic layers and the spectral composition of light corresponds to the spectral behavior for light scattering by these layers, and this behavior is in turn determined by the average size of the silver halide crystals in the given emulsion. Layers with small crystals scatter chiefly blue rays, and therefore the /60 resolution of these layers is lower in blue rays than in red. Layers with larger emulsion crystals scatter chiefly red rays, and therefore their resolution is lower in red rays than in blue.

The average size of the emulsion crystals in infrared films is about 1 μ^2. The spectral behavior for light scattering by emulsions of this type was studied by Pruss (ref. 6). It was found that these layers scatter infrared rays considerably more intensely than blue, as may be seen from the graphs presented in the paper. This explains the reduced value of R in infrared rays as compared with R in blue rays for the given infrared films.

The resolution of films in "white light" (lamp without filter), as may be seen from tables 1 and 2, occupies an intermediate position determined by the relative contribution of blue and infrared rays in formation of the image. Thus, R in white light for I-810 film is close to that in infrared rays, since the image is formed chiefly by infrared light, as may be seen from the curve for the spectral sensitivity of this film (ref. 2) and from the curve for spectral scattering of energy in the light of an incandescent lamp. On the other hand, R in white light for I-1030 and I-1070 films approaches R for blue rays since the contribution of infrared rays to formation of the image is small due to the low degree of sensitization for these films.

The microphotometric grain size for infrared films, i.e., the mean square fluctuation in the transmission coefficient σ_T of a uniformly exposed and developed section of the layer, was measured by a previously described method (ref. 7). This fluctuation was approximately identical for all four types of films: σ_T=0.060 for D=0.5 with development for five minutes in Chibisov developer.

Thus, infrared films are approximately the same as Panchrome type 10 or astronomic A-500 film with respect to microphotometric grain size (ref. 7).

It is interesting that the microphotometric grain size was identical when the film was exposed through blue and red filters while the resolution in these cases, as we have seen, differs by a factor of 2. This shows once again that there is no direct relationship between resolution and grain size, as was pointed out previously (ref. 8).

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